United Steelworkers of America
AFL-CIO/CLC
Five Gateway Center
Pittsburgh, PA 15222
(412) 562-2400 • FAX (412) 562-2484

May 20, 1994

Mr. Frank Gardner
Permit Writer
U. S. Environmental Protection Agency, Mail Stop H-44
75 Hawthorne St.
San Francisco, CA 94105

Subject: RSR Quemetco corrective action, antimony clean-up

Dear Mr. Gardner:

As you know, our union has been conducting research into the environmental record of RSR Corporation. In reviewing plans for clean-up of RSR's active and closed smelters, we have become concerned that insufficient attention is being paid to antimony contamination at these sites.

Antimony accompanies lead in RSR's smelting process. Data from the Toxic Release Inventory indicate that the antimony content of RSR's slag is more than half the lead content, and RSR also emits antimony into the air. Antimony is much more toxic than lead.

Under USEPA risk assessment guidance, antimony-contaminated soils in residential areas should be cleaned up to a level of 30 mg/kg. We urge you to adopt this as your clean-up target. A lesser clean-up would put the health of children at risk.

A technical memorandum from our consultants on antimony clean-up targets is enclosed.

Thank you very much for your consideration of this matter.

Sincerely,

James P. Valenti
Intl. Health and Safety Representative

Region 9 PRGs:
residential 31 ppm
industrial 820 ppm

cc (w/enc): Guillermo Hernandez, DTSC
Andy Cano, DTSC
John Moore, City of Los Angeles
Trianna Silton, Center for Community Action & Environmental Justice
Amy Wohl, Los Angeles Fire Dept.

MEMORANDUM

The Hampshire Research Institute
1600 Cameron Street, Suite 100
Alexandria, VA 22314-2705

Voice 703/683-6695
Fax 703/684-7704

Date: May 20, 1994
To: Benjamin Ross, Ph.D., President, Disposal Safety Incorporated
From: John S. Young, Ph.D. JSY
Re: Risks from soils contaminated with antimony.

Per your request, I have conducted a brief assessment of the risks associated with soil that has been contaminated with antimony[1]. As noted below, this analysis indicates that concentrations of antimony in excess of 30 milligrams per kilogram of soil would raise concern over possible toxic effects in children.

As you know, the risks associated with soil contamination depend upon the nature and extent of exposure to the contaminated soil. Among the ways in which people can be exposed to such contaminated soil are:

- Inhalation of dust (airborne soil). This can occur both outside and indoors. Wind, traffic (both foot and vehicle), and other routine activities (such as digging in a garden) can generate dust from contaminated soil.
- Ingestion of fruits and vegetables grown in contaminated soil. This is primarily a problem where home gardens provide a significant part of the diet. Different types of fruits and vegetables will take up various soil contaminants to different degrees.
- Incidental (accidental) ingestion of soil (for example, by playing in a yard, and eating a sandwich with unwashed hands). This is generally considered to be a common exposure pathway for both adults and children, and is routinely evaluated as an exposure pathway in risk assessments conducted by the US EPA. Children are assumed to ingest a great deal more soil this way, relative to their size, than do adults.
- Deliberate ingestion of soil. This is a cultural practice among adults in some parts of the country. Of course, eating non-food objects (pica) is a widely-known problem for young children.

Because predicting the concentrations of antimony in garden fruits and vegetables that would result from growing them in contaminated soil is a very uncertain process, I have not examined this exposure pathway. Neither have I addressed deliberate ingestion of soils (pica), because it is impossible to obtain data on the amount of soil ingested in the course of "average" pica behavior. My examination of exposure has been limited to dust inhalation and incidental (accidental) ingestion of soil. Because children and adults differ significantly with respect to this accidental consumption, they have been evaluated separately.

[1] A set of print-outs are attached.

Exposures

Using standard exposure assumptions, the exposures from incidental ingestion are significantly higher than those from dust inhalation. This reflects the fact that the dust concentration used in the calculations is the annual average US dust concentration (also equal to the national ambient air quality standard). For a dusty area (such as a home adjoining an open, unvegetated field) this may underestimate inhalation exposures significantly.

As noted above, it is generally assumed by risk assessors that children will ingest more soil accidentally than do adults, and that there smaller body size exacerbates the problem. I have used standard US EPA default assumptions for incidental soil ingestion. These are obtained from the following US EPA documents:

> OSWER Directive 9285.6 03, 3/25/91. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual. Supplemental Guidance, Standard Exposure Factors:Interim Final.*
>
> EPA/600/8-89/043, March 1989, *Exposure Factors Handbook: Final Report*

What the US EPA assumes is that a child is exposed for six years of life, consumes 200 milligrams per day of soil (this is approximately seven one-thousandths of an ounce), and has an average body weight of 15 kilograms (33 pounds) during the time of exposure. These estimates have been selected to avoid underestimating accidental soil consumption, but it should be remembered that they do not address pica behavior.

Risks

The US EPA's *Integrated Risk Information System* database contains an estimate of an oral Reference Dose for Antimony. This Reference Dose (RfD) is an estimate of the amount of a substance that can be ingested every day for a prolonged period, without undue risk of toxic effects. Ingesting amounts in excess of the RfD for a prolonged period may lead to toxic effects.

For antimony, the RfD is 0.0004 milligrams (0.4 micrograms) of antimony per kilogram of body weight per day[2]. If the average concentration of antimony in soil around the child's house, or in an area where the child generally played, was slightly greater than 30 milligrams of antimony per kilogram of soil, this RfD would be exceeded, and there would be concern over possible toxicity. If dust inhalation were a significant factor at the site, or if the child was exposed for significantly longer than six years, even lower levels of contamination might lead to toxic effects.

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[2] Reference doses are expressed relative to body weight. In general, a larger person can ingest more of a poison before ill effects become apparent.

Toxicity

The US Agency for Toxic Substances and Disease Registry has summarized the toxicity of antimony (TP-91/02, 1992).

Antimony can lead to gastrointestinal symptoms (such as vomiting and diarrhea) of varying severity when ingested, and can cause a number of inflammatory conditions of the eyes, skin, and airways when inhaled. It is used in various medicines to treat infection by parasites; overdoses with these medicines have lead to vomiting, diarrhea, joint and muscle pain, anemia, and abnormalities in electrocardiograms. Workers exposed to elevated levels for prolonged periods have shown electrocardiogram abnormalities, and there is some evidence of birth defects among the children of female workers (this last study was poorly documented.)

In animal studies, prolonged inhalation exposure to antimony has lead to fibrotic airways damage in rats; intermediate exposures were associated with electrocardiogram abnormalities in rats, rabbits, and dogs, corroborating the limited data available in exposed workers

The US EPA's RfD was based upon the finding of a reduced lifespan in exposed rats.

SITE: antimony.SIT (filename)

Exposure Description: Exposure for Antimony

1.0 Approach

The procedures used by RISK*ASSISTANT to calculate exposures have been reviewed by the Office of Health and Environmental Assessment of the U.S. EPA. Default parameters for calculating exposures have been extracted from these EPA documents:

Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors" Interim Final (OSWER Directive 9285.6-03; March 25, 1991)

Exposure Factors Handbook (EPA/600/8-89/043; March 1989).

2 Sample Data

The following table lists the environmental media considered in this analysis (out of a possible set of groundwater, surface water, air, soil, sediment and biota). The table also indicates the technique used to combine data from multiple samples in each medium, and the sample set that was included. The final column indicates the approach used to assign proxy concentrations when a chemical was not detected in some of the samples.

MEDIUM	AGGREGATION STRATEGY	SAMPLE SET	TREATMENT OF NON-DETECTS
Soil	Single Sample		

The aggregation of sample data described above produced the following data set of chemicals and concentrations in each medium under consideration:

CONCENTRATION OF CHEMICALS IN ENVIRONMENTAL MEDIA COVERED BY THIS ANALYSIS

MEDIUM	CHEMICAL NAME	CONCENTRATION	(UNITS)
Soil			
7440-36-0	ANTIMONY	3.000e+001	(mg/kg)

3 Exposure Pathways

It is important to remember that the calculated doses and concentrations presented in this assessment refer only to the specific exposure pathways enumerated in this assessment. An exposure pathway combines contamination in an environmental medium, a scenario describing how a person contacts that medium, and a route of exposure (oral, inhalation, or dermal). An assessment that incorporates other pathways of exposure, or that does not incorporate all of the pathways described in this analysis, will yield different values. The following list indicates the pathways considered in this assessment:

Soil:

Inhalation of Particulates Inside Residence (Inhalation)
Inhalation of Particulates Outside Residence (Inhalation)
Ingestion of Soil (Child) (Oral)
Ingestion of Soil (Adult) (Oral)

3.1 Cross-Media Transfer Equations Used to Generate Exposure Estimates

For some exposure scenarios a contaminant concentration specified in one environmental medium must be converted to a concentration in another medium, to which a person is exposed. (For example, in order to evaluate inhalation exposures while showering, contaminant concentrations in domestic water must be converted to concentrations in bathroom air.) The following equations were used in this assessment to predict such cross-media contaminant transfers in each of the indicated exposure scenarios.

INHALATION OF PARTICULATES INSIDE THE RESIDENCE - Soil to respirable Particulates

REFERENCES: (1) Wark, K. & Warner, C.F. (1981). AIR POLLUTION: ITS ORIGIN AND CONTROL, Second Ed., New York: Harper & Row. (2) Hawley, J.K. (1985). Assessment of Health Risk from Exposure to Contaminated Soil. Risk Analysis, 5, 2[illegible].

EQUATION: C(i) = D * R * CF * C(s)

PARAMETER DEFINITION

		DEFAULT (calculated)	USED (chemical specific)
C(i)	Inhaled concentration of contaminant (ug/cu m)		
C(s)	Concent. in soil (ug/cu m)		
R	Respirable Fraction of Dust:	0.73	0.73
CF	Proportion of Contaminated Dust:	0.80	0.80
D	Dust Concentration (ug/cu m):	56.00	56.00

INHALATION OF PARTICULATES OUTSIDE THE RESIDENCE - Soil to respirable Particulates

REFERENCES: Wark, K. & Warner, C.F. (1981). AIR POLLUTION: ITS ORIGIN AND CONTROL, Second Ed., New York: Harper & Row.

EQUATION: C(i) = D * R * CF * C(s)

PARAMETER DEFINITION

		DEFAULT (calculated)	USED (chemical specific)
C(i)	Inhaled concentration of contaminant (ug/cu m)		
C( )	Concent. in soil (ug/cu m)		
R	Respirable Fraction of Dust:	0.73	0.73
CF	Proportion of Contaminated Dust:	1.00	1.00
D	Dust Concentration (ug/cu m):	75.00	75.00

3.2 Exposure Parameters

The dose (or exposure concentration) values presented in this assessment reflect not only the concentrations of contaminants in various environmental media and the exposure pathways selected for analysis, but also the specific numerical parameters applied to each exposure scenario. The following tables summarize the exposure parameters used in this assessment.

Exposure Parameters Used to Generate Exposure Estimates

ORAL SCENARIOS	CONSUMPT RATE (units/event)	CONT.FRAC or EVENT DUR(h)	EVENT FREQ (event/y)	EXPOSURE PERIOD(y)	WEIGHT (kg)	LIFE-TIME(y)
Ing. of Soil(Child	200.00 mg/e	1.00	350.00	6.00	15.00	70.00

Exposure Parameters Used to Generate Exposure Estimates

ORAL SCENARIOS	CONSUMPT RATE (units/event)	CONT.FRAC or EVENT DUR(h)	EVENT FREQ (event/y)	EXPOSURE PERIOD(y)	WEIGHT (kg)	LIFE-TIME(y)
Ing. of Soil(Adult	100.00 mg/e	1.00	350.00	24.00	70.00	70.00

Exposure Parameters Used to Generate Exposure Estimates

INHALATION SCENARIOS	INHALATION RATE (m3/h)	EVENT DUR.(h)	EVENT FREQ (events/y)	EXPOSURE PERIOD(y)	WEIGHT (kg)	LIFE-TIME(y)
Particles Indoors	0.71	21.00	350.00	30.00	70.00	70.00
Particles Outside	1.67	3.00	350.00	30.00	70.00	70.00

4.0 Exposure Estimates

When an exposure assessment will be used as part of a quantitative risk assessment, a numerical estimate of exposure must be calculated. The value employed for this estimate varies, according to the route of exposure.

For oral or dermal exposures, a dose rate (mass of chemical per unit time), adjusted for body weight, is calculated; it is generally expressed in units of mg/kg/day. However, oral exposure estimates employ applied dose, while dermal exposures use absorbed dose. This may require a corresponding selection or adjustment of toxic hazard data for risk estimates. The U.S. EPA has decided to evaluate risks from inhalation exposure on the basis of contaminant concentration in air, rather than dose (Interim Methods for Development of Reference Doses, EPA/600/8-88/066F).

When evaluating the risk of chronic non-cancer health effects from oral or dermal exposures, EPA employs the Average Daily Dose (ADD) received during the period of exposure. These are compared to Reference Doses (RfDs). When evaluating such effects from inhalation exposure, EPA employs contaminant concentrations, which are compared to Reference Concentrations (RfCs) for continuous exposure. If exposures occur for relatively short durations (less than 8 hours), care should be taken in comparing exposure concentrations to reference concentrations.

When evaluating carcinogenic risks from exposures that last less than a lifetime, the ADD or exposure concentration is adjusted to a dose rate that would yield an equivalent exposure if exposure continued for the entire lifetime.

For oral or dermal exposures, this yields the Lifetime Average Daily Dose (LADD):

LADD = ADD * (exposure period in years / lifetime in years)

For inhalation exposures, this yields the Adjusted Concentration:

Adjusted Concentration = Concentration * (exposure period / lifetime)

Typically (and in RISK*ASSISTANT), the adjusted concentration will also incorporate other adjustments for differences between the actual exposure pattern and the assumed pattern of continuous lifetime exposure. For example, if exposure only occurred for one hour each day, the Adjusted Concentration would be only 1/24th of the concentration during that hour.

EXPOSURE SUMMARY:AVERAGE DAILY DOSE (mg/kg/d) OR EXPOSURE CONCENTR. (mg/cu m)

MEDIUM/SCENARIO CHEMICAL(S)	CONCENTRATION units:see note below	ORAL ADD	INHALATION CONCENT.	DERMAL ADD
Soil - Inhalation of Particulates Inside Residence				
7440-36-0 ANTIMONY			9.8E-007	
Soil - Inhalation of Particulates Outside Residence				
7440-36-0 ANTIMONY			1.6E-006	
Soil - Ingestion of Soil (Child)				
7440-36-0 ANTIMONY		3.8E-004		
Soil - Ingestion of Soil (Adult)				
7440-36-0 ANTIMONY		4.1E-005		
Soil - TOTAL				
7440-36-0 ANTIMONY		4.2E-004		********

NOTE:water:ug/l; air:mg/cu m; soil,sediment:mg/kg & biota:ug/kg. Cl: conc. in leaf/stem/fruit; Cr: conc.in root. '-':needed chemical properties not available

EXPOSURE SUMMARY:LIFETIME AVG DAILY DOSE(mg/kg/d) OR ADJ. CONCENTR. (ug/cu m)

MEDIUM/SCENARIO CHEMICAL(S)	CONCENTRATION units:see note below	ORAL LADD	ADJUSTED CONCENT.	DERMAL LADD
Soil - Inhalation of Particulates Inside Residence				
7440-36-0 ANTIMONY	9.8E-007		3.0E-004	
Soil - Inhalation of Particulates Outside Residence				
7440-36-0 ANTIMONY	1.6E-006		1.7E-004	
Soil - Ingestion of Soil (Child)				
7440-36-0 ANTIMONY		3.3E-005		
Soil - Ingestion of Soil (Adult)				
7440-36-0 ANTIMONY		1.4E-005		
Soil - TOTAL				
7440-36-0 ANTIMONY		4.7E-005	4.7E-004	********

NOTE:water:ug/l; air:mg/cu m; soil,sediment:mg/kg & biota:ug/kg. Cl: conc. in leaf/stem/fruit; Cr: conc.in root. '-':needed chemical properties not available

5.0 Uncertainties

To understand the meaning of the quantitative dose estimates presented in this assessment, it is necessary to consider the key assumptions used in deriving them, and the uncertainties associated with those assumptions:

- A key assumption is that the concentrations specified for various environmental media represent the true concentrations to which people will be exposed during the period of exposure. Actual contaminant concentrations will likely vary across both time and space.

- The selection of exposure scenarios will also have a significant influence on estimated doses. Actual exposures to members of any specified population will vary in accordance with the degree to which they participate in the activities described by the exposure scenarios.

- Similarly, the numerical parameter values applied to each exposure scenario will have a marked effect on exposure. The default values provided are estimates for the entire U.S. population. Various demographic factors (including geographic region, rural or urban setting, socioeconomic status and ethnic heritage) may call for significant alterations in these values.

The uncertainty analyses provided as an option by RISK*ASSISTANT can illustrate the differences between your calculated doses and those calculated using standard (average or reasonable maximum exposure) numerical parameter values for each scenario you have selected. They can also provide information on the way in which your selection of exposure scenarios influences your estimates.

These uncertainty analyses do not consider uncertainty regarding chemical concentration measurements or the variability of chemical concentrations across space and time. Neither do they address uncertainty associated with models of contaminant transport or inter-media transfer of contaminants. Because both chemical concentrations and the patterns of activity that result in exposure will vary, the actual range of possible doses at any site may be greater than the range covered by RISK*ASSISTANT's uncertainty analyses.

5.1 Uncertainties Regarding Exposure Parameters

O. estimate of the uncertainty associated with the exposure estimates presented in this report is provided by an examination of the ways in which using alternative values for numerical exposure parameters can change the resulting exposure values. The following tables present alternative dose estimates (ADDs and LADDs) for each chemical, when exposure is calculated using 1) average values for all exposure parameters, 2) the values actually used for all parameters, and 3) reasonable maximum exposure (default) values for all parameters. These values indicate the range of doses that might be expected to occur for each exposure scenario, and the position of the dose calculated by the user within (or possibly outside of) this range. Following these tables are additional tables that present, for each scenario, the alternative parameter values.

Because inhalation exposures (during the exposure period) are expressed as concentrations, rather than doses, it is not possible to perform a similar uncertainty analysis for these exposure estimates. It is possible, however, to analyze the influence of exposure parameters on the adjusted concentrations.

Oral Exposures

INFLUENCE OF ALTERNATIVE PARAMETERS ON ADD AND LADD (mg/kg/d)

MEDIA/SCENARIOS	ADD			LADD		
	Average	User	R.Max.Exp.	Average	User	R.Max.Exp.
Soil 7440-36-0 ANTIMONY						
Ing. of Soil(Child	3.0E-004	3.8E-004	3.8E-004	1.3E-005	3.3E-005	3.3E-005
Ing. of Soil(Adult	3.2E-005	4.1E-005	4.1E-005	4.1E-006	1.4E-005	1.4E-005
ALL SCENARIOS......	3.3E-004	4.2E-004	4.2E-004	1.7E-005	4.7E-005	4.7E-005

Inhalation Exposures

INFLUENCE OF ALTERNATIVE PARAMETERS ON ADJUSTED CONCENTRATION

MEDIA/SCENARIOS	ADJUSTED CONCENTRATION		
	Average	User	R.Max.Exp.
Soil 7440-36-0 ANTIMONY			
Particles Indoors	6.3E-005	3.0E-004	3.0E-004
Particles Outside	6.2E-006	1.7E-004	1.7E-004
ALL SCENARIOS......	6.9E-005	4.7E-004	4.7E-004

Alternative Exposure Parameters: Actual Values and Values Expressed as a Percentage of User-specified Values

Oral Exposure

Ingestion of Soil (Child) - Alternative Parameter Values

Parameter (units)	User Value	Average Value	(Percent of User)	Reasonable Max. Exp.	(Percent of User)
Body Weight (kg)	15.00	15.00	100.0	15.00	100.0
Event Freq. (events/y)	350.00	274.00	78.3	350.00	100.0
Exposure Duration (y)	6.00	3.00	50.0	6.00	100.0
Lifetime (y)	70.00	70.00	100.0	70.00	100.0
Consum. Rate(units/event)	200.00	200.00	100.0	200.00	100.0
Cont.Frac./Event Dur(h)	1.00	1.00	100.0	1.00	100.0

Ingestion of Soil (Adult) - Alternative Parameter Values

Parameter (units)	User Value	Average Value	(Percent of User)	Reasonable Max. Exp.	(Percent of User)
Body Weight (kg)	70.00	70.00	100.0	70.00	100.0
Event Freq. (events/y)	350.00	274.00	78.3	350.00	100.0
Exposure Duration (y)	24.00	9.00	37.5	24.00	100.0
Lifetime (y)	70.00	70.00	100.0	70.00	100.0
Consum. Rate(units/event)	100.00	100.00	100.0	100.00	100.0
Cont.Frac./Event Dur(h)	1.00	1.00	100.0	1.00	100.0

Alternative Exposure Parameters: Actual Values and Values Expressed as a Percentage of User-specified Values

Inhalation Exposure

Inhalation of Particulates Inside Residence - Alternative Parameter Values

Parameter (units)	User Value	Average Value	(Percent of User)	Reasonable Max. Exp.	(Percent of User)
Body Weight (kg)	70.00	70.00	100.0	70.00	100.0
Event Freq. (events/y)	350.00	350.00	100.0	350.00	100.0
Exposure Duration (y)	30.00	9.00	30.0	30.00	100.0
Lifetime (y)	70.00	70.00	100.0	70.00	100.0
Inhalation Rate (cu m/h)	0.71	0.63	88.7	0.71	100.0
Event Duration (h)	21.00	16.43	78.2	21.00	100.0

Inhalation of Particulates Outside Residence - Alternative Parameter Values

Parameter (units)	User Value	Average Value	(Percent of User)	Reasonable Max. Exp.	(Percent of User)
Body Weight (kg)	70.00	70.00	100.0	70.00	100.0
Event Freq. (events/y)	350.00	350.00	100.0	350.00	100.0
Exposure Duration (y)	30.00	9.00	30.0	30.00	100.0
Lifetime (y)	70.00	70.00	100.0	70.00	100.0
Inhalation Rate (cu m/h)	1.67	1.40	83.8	1.67	100.0
Event Duration (h)	3.00	0.44	14.7	3.00	100.0

5.2 Uncertainties Regarding Exposure Scenarios

An alternative approach to estimating the uncertainty associated with the dose estimates presented in this report is to identify which scenarios, and which contaminated environmental media, make the greatest contribution to the exposure for any given contaminant. For example, if a person is exposed to a surface water contaminant both by drinking water and eating fish, one can ask what portion of the ADD or LADD of the contaminant comes from water ingestion, and what proportion from fish consumption. This information can also help to guide the selection of remedial strategies for minimizing exposure to the contaminants. The following tables present the percentage contribution of each evaluated scenario and medium to the total ingested dose of each contaminant.

Because inhalation exposures are calculated as concentrations, rather than doses, it is not possible to calculate the relative contribution of each inhalation scenario to total inhalation exposure. Potential disparities in exposure durations and other parameters could invalidate comparisons between inhaled concentrations in different scenarios. The adjusted concentrations take such differences in exposure parameters into account, and meaningful comparisons between them can be made.

Relative Contributions of Scenarios and Media to Route-Specific Exposures(%)

Media/Scenarios	Oral ADD	Oral LADD	Inhalation ADJ. CONC.	Dermal ADD	Dermal LADD
CHEMICAL 7440-36-0 ANTIMONY					
Soil (3.000e+001 mg/kg)					
Particles Indoors			64		
Particles Outside			36		
Ing. of Soil(Child)	90	70			
Ing. of Soil(Adult)	10	30			
ALL SCENARIOS...............	100	100	100	---	---

6.0 References

. EPA/600/8-89/043 Exposure Factors Handbook, Final Report. U.S. EPA, Office Office of Health and Environmental Assessment. Washington, D.C.

. OSWER Directive 9285.66-03, 3/25/91. Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual. Supplemental Guidance, Standard Exposure Factors: Interim Final.

. EPA/540/1-89/002 Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual.

. Exposure Description: Exposure for Antimony

. Wark, K. & Warner, C.F. (1981). AIR POLLUTION: ITS ORIGIN AND CONTROL, Second Ed., New York: Harper & Row. (2) Hawley, J.K. (1985). Assessment of Health Risk from Exposure to Contaminated Soil. Risk Analysis, 5, 289.

>>>>>>>>>>>>>>>>>>>>>>>>>>>>>END OF REPORT<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<

SITE: antimony.SIT (filename)

Exposure Description: Exposure for Antimony

1.0 Approach

The procedures used by RISK*ASSISTANT to calculate exposures and risks have been reviewed by the Office of Health and Environmental Assessment of the U.S. EPA. Default parameters for calculating exposures have been extracted from these EPA documents:

Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual, Supplemental Guidance "Standard Exposure Factors" Interim Final (OSWER Directive: 9285.6-03, March 25, 1991)

Exposure Factors Handbook (EPA/600/8-89/043; March 1989).

Where available, cancer potencies, unit risks, reference concentrations, and reference doses were obtained from the Integrated Risk Information System (IRIS). All values in IRIS have been reviewed and accepted for Agency-wide use by EPA. For chemicals not included in IRIS, toxicity data were extracted from the Health Effects Assessment Summary Tables (HEAST), distributed by the Office of Emergency and Remedial Response.

The toxic hazard data used to prepare this report were current as of the date supplied for the database. However, these values may have been modified since the update of the database. Users are urged to consult IRIS and the latest HEAST tables directly.

2.0 Sample Data

The following table lists the environmental media considered in this analysis (out of a possible set of groundwater, surface water, air, soil, sediment and biota). The table also indicates the technique used to combine data from multiple samples in each medium, and the sample set that was included. The final column indicates the approach used to assign proxy concentrations when a chemical was not detected in some of the samples.

MEDIUM	AGGREGATION STRATEGY	SAMPLE SET	TREATMENT OF NON-DETECTS
Soil	Single Sample		

The aggregation of sample data described above produced the following data set of chemicals and concentrations in each medium under consideration:

CONCENTRATION OF CHEMICALS IN ENVIRONMENTAL MEDIA COVERED BY THIS ANALYSIS

MEDIUM	CHEMICAL NAME	CONCENTRATION	(UNITS)
Soil			
7440-36-0	ANTIMONY	3.000e+001	(mg/kg)

3.0 Exposure Pathways

The dose and concentration estimates used to calculate the risks presented in this assessment refer only to the specific exposure pathways enumerated in the assessment, and depend upon the specific exposure parameters used for calculation. An exposure pathway combines contamination in an environmental medium, a scenario describing how a person contacts that medium, and a route of exposure (oral, inhalation, or dermal). An assessment that incorporates other pathways of exposure, or that does not incorporate all of the pathways described in this analysis, will yield different risk estimates. Further, exposure and risk totals for each medium involve the assumption that the same individual experiences all scenarios corresponding to that medium.

Soil :

Inhalation of Particulates Inside Residence (Inhalation)
Inhalation of Particulates Outside Residence (Inhalation)
Ingestion of Soil (Child) (Oral)
Ingestion of Soil (Adult) (Oral)

4.0 Toxic Haxards

The risk estimates presented in this assessment reflect not only the specific exposure pathways evaluated, but also estimates of the inherent toxic hazards posed by each chemical assessed.

Carcinogenic hazards are estimated as the slope of the dose-response or concentration-response function. The steeper the slope of this function, the smaller the dose, or the lower the concentration, required to produce a particular level of risk. It is generally assumed that carcinogenic risk is zero only when exposure is zero, and that at low doses, the relationship between dose and response can be approximated by a straight line. For oral exposures, the slope of the dose-response function (Slope Factor) is used as the estimate of carcinogenic hazard. For inhalation exposures, the slope of the concentration-response function (Unit Risk) is used.

It is generally assumed that non-cancer toxic effects have some threshold. That is, up to some finite level of exposure, physiological defense mechanisms ensure that no toxic effect will occur. Accordingly, hazard assessment for non-carcinogenic effects involve estimating an exposure that is less than this threshold level. This is done by applying "uncertainty factors" to exposures that appear to be near this threshold in laboratory toxicology studies. This yields a Reference Dose (RfD) for oral exposures, or a Reference Concentration (RfC) for inhalation exposures.

Because toxicity data from studies using dermal exposure are generally not available, hazard estimates from studies using oral exposures (Slope Factors and RfDs) are usually employed to assess risks from dermal exposures. However, because oral toxicity data generally represent administered dose, while dermal exposure evaluation provides estimates of absorbed dose, risk estimates for dermal exposure may underestimate the actual risks of dermal exposure. This reflects the fact that the absorbed dose in an oral toxicity study may be significantly less that the administered dose. Hence a Reference Dose (RfD) derived from the administered dose may be considerably larger than would be the case if the absorbed dose was known and was used to derive the RfD.

When an assessor has information on the pharmacokinetics of a chemical, it is appropriate to adjust for differences between oral and dermal absorption in the calculation of risks from dermal exposure. The procedures employed in this version of RISK*ASSISTANT assume complete absorption of orally administered doses.

Appendix A of the Risk Assessment Guidance for Superfund. Volume 1. Human Health Evaluation Manual (Part A) (EPA/540/1-89/002, December, 1989) contains a discussion of appropriate adjustment procedures.

Where possible, carcinogenic Slope Factors and Unit Risks, and Reference Doses and Reference Concentrations for non-cancer hazards, have been obtained from the Integrated Risk Information System (IRIS). All values in IRIS have been reviewed and accepted for Agency-wide use by EPA. For chemicals not included in IRIS, toxicity data have been extracted from the Health Effects Assessment Summary Tables (HEAST), distributed on behalf of EPA's Office of Emergency and Remedial Response. Risk estimates derived using these latter values are marked by an asterisk (*).

Slope Factors and Unit Risks are generally estimated as the 95th percentile confidence limits using the linearized multistage model. As such, they are conservative estimates of toxic hazard. Risks estimated by combining these hazard values with exposure estimates are commonly referred to as upper-bound risks, but because exposure estimates may not represent upper-bound estimates, risk estimates are not true upper-bound risks.

A similar effort is made to ensure that Reference Doses and Reference Concentrations provide a conservative estimate of non-cancer toxic hazards. The uncertainty factors applied to toxicity data are intended to take into account differences in sensitivity to toxic effects within and between species, and differences in toxic effects between chronic and subchronic exposures.

5.0 Risk Estimates

Different approaches are used in the calculation of risk for chemicals that may cause cancer (carcinogens) and for chemicals with other toxic effects. For chemicals that may cause cancer if ingested, risk is calculated as a function of oral slope factor and dose:

$$Risk = 1 - e^{-(\text{Oral Slope Factor} * \text{Lifetime Average Daily Dose})}$$

If the risk results from breathing the chemical, the calculation is based on concentration, rather than dose, as follows:

$$Risk = 1 - e^{-(\text{Unit Risk} * \text{Concentration})}$$

For dermal exposures, the calculated dermally absorbed dose is used in combination with the oral slope factor, using the same equation that is used for calculating risks from oral exposures. As noted above, this may lead to some underestimation of dermal risk.

These estimates represent the theoretical excess cancer risk (i.e. risk over background cancer incidence) of developing cancer. For example, if the calculated risk is 1 E-6, this would literally suggest that a person would have a one-in-a-million chance of getting cancer because of the specified chemical exposure, in addition to her/his chance of getting cancer from other causes. However, in view of the large uncertainties associated with such risk estimates, they should always be interpreted as general indicators, rather than precise estimates. EPA generally considers risks below 1 E-6 to be low.

RISK SUMMARY FOR ALL SCENARIOS - CARCINOGENIC RISKS

MEDIUM/SCENARIO CHEMICAL(S)	CONCENTRATION UNITS:SEE NOTE	W.O.E CLASS	LADD or ADJ.CONC.	SLOPE(*) or U. RISK	RISK
Soil - Inhalation of Particulates Inside Residence					
7440-36-0 ANTIMONY			3.0E-004	--------	------
Soil - Inhalation of Particulates Outside Residence					
7440-36-0 ANTIMONY			1.7E-004	--------	------
Soil - Ingestion of Soil (Child)					
7440-36-0 ANTIMONY			3.3E-005	--------	------
Soil - Ingestion of Soil (Adult)					
7440-36-0 ANTIMONY			1.4E-005	--------	------

NOTE:water:ug/l; air:mg/cu m; soil,sediment:mg/kg & biota:ug/kg. '*': HEAST. Cl: conc. in leaf; Cr: conc. in root. '-': no chemical properties or no hazard info

Definitions [and units of measurement] of abbreviations employed in the preceding table:

LADD	= Lifetime Average Daily Dose [mg/kg/d]
ADJ. CONC.	= Adjusted Concentration: Continuous concentration equivalent to exposure concentration [ug/cu.m.]
SLOPE (OR)	= Slope Factor of the (carcinogenic) dose-response function. [1/(mg/kg/d)]
U. RISK	= Slope of the concentration-response function [1/(ug/cu.m.)]
W.O.E. CLASS	= Weight of evidence for human carcinogenicity
A	= Known human carcinogen.
B1	= Probable human carcinogen, limited human data.
B2	= Probable human carcinogen, inadequate or no human data.
C	= Possible human carcinogen.
D	= Not classifiable as human carcinogen.
E	= Evidence that not carcinogenic in humans.
RISK	= Probability of getting cancer from specified exposure.

For agents that cause non-cancer toxic effects, a Hazard Quotient (H.Q.) is calculated, which compares the expected exposure to the agent to an exposure that is assumed not to be associated with toxic effects.

For oral or dermal exposures, the Average Daily Dose (ADD) is compared to a Reference Dose (RfD):

H.Q. = Average Daily Dose / Reference Dose

For inhalation exposures, the inhaled concentration is compared to a Reference Concentration (RfC):

H.Q. = Inhaled Concentration / Reference Concentration

A Hazard Index, representing the sum of the Hazard Quotients for each chemical and exposure scenario to which a given person may be exposed, is used to evaluate the likelihood of non-cancer toxicity. Hazard Indices < 1.0 are generally considered by EPA to be associated with low risks on non-cancer toxic effects.

As noted above, H.Q.s for dermal exposures compare absorbed doses to oral RfDs that were derived from administered doses. Even if one does not take into account the possibility of route-specific toxic effects that would be overlooked by this procedure, it is important to remember that this may lead to the underestimation of risks from dermal exposures.

The user should also bear in mind that the development of Reference Concentrations is predicated upon continuous or prolonged exposure; exposures for brief periods that exceed the Reference Concentration may not be associated with adverse effects.

RISK SUMMARY FOR ALL SCENARIOS - NON-CANCER RISKS

MEDIUM/SCENARIO CHEMICAL(S)	CONCENTRATION UNITS:SEE NOTE	ADD or INH.CONC	RfD(*) or RfC	HQ
Soil - Inhalation of Particulates Inside Residence				
7440-36-0 ANTIMONY		9.8E-007	--------	------
Soil - Inhalation of Particulates Outside Residence				
7440-36-0 ANTIMONY		1.6E-006	--------	------
Soil - Ingestion of Soil (Child)				
7440-36-0 ANTIMONY		3.8E-004	4.0E-004	1E+000
Soil - Ingestion of Soil (Adult)				
7440-36-0 ANTIMONY		4.1E-005	4.0E-004	1E-001

NOTE:water:ug/l; air:mg/cu m; soil,sediment:mg/kg & biota:ug/kg. '*': HEAST. Cl: conc. in leaf; Cr: conc. in root. '-': no chemical properties or no hazard info

Definitions [and units of measurement] of abbreviations employed in the preceding table:

ADD = Average Daily Dose (during exposure period) [mg/kg/d]
INH.CONC. = Concentration of contaminant in inhaled air [mg/cu.m.]
RfC = Reference Concentration (concentration not associated with toxicity) [mg/cu.m.]
RfD = Reference Dose (daily dose not associated with toxicity) [mg/kg/d]
H.Q. = HAZARD QUOTIENT (Ratio of ADD to RfD, or of INH.CONC. to RfC)

6.0 Combining Risk Across Chemicals and Exposure Routes

In general, RISK*ASSISTANT reports present risks that are specific to a particular chemical and route of exposure. Risks are not combined across chemicals, or across routes of exposure. This is because one can not assume that a given chemical will produce the same toxic effects by all routes of exposure, and different chemicals produce different ranges of toxic effects.

In some situations, it is appropriate for the user to calculate such combined risks. Many chemicals will produce the same toxic effect, regardless of the exposure route. For chemicals that cause cancer by several routes of exposure, the combined risk from all routes may be more informative than route-specific risk estimates, unless there is evidence that carcinogenic risks from different routes reflect different mechanisms of action. Similarly, for non-cancer toxic effects, differences between routes may only affect toxic potency, which will be reflected in the use of route-specific Reference Doses or Reference Concentrations. A combined hazard index for all routes of exposure may be more informative than route-specific hazard indices in such cases.

It may be appropriate to calculate an estimate of total carcinogenic risk for all carcinogenic chemicals to which your population is exposed. Similarly, computing a global hazard index is appropriate for a set of chemicals that have overlapping patterns of toxicity. RISK*ASSISTANT does not automatically make such calculations, which should be preceded by careful consideration of the specific chemicals covered by the assessment.

In generating estimates of the combined toxic and carcinogenic risks of different chemicals, it is also important to bear in mind that the risks of exposure to multiple chemicals are not necessarily additive. Risks may be less than additive, or synergism may lead to risks that are greater than would be predicted by an additive model. Unfortunately, only very limited data are available on the risks of exposure to multiple chemicals.

7.0 Uncertainties

Because risk values incorporate all of the estimates, default values, and assumptions used throughout risk assessment, the values presented in these tables must be understood in terms of key uncertainties regarding both the toxic hazard values and the exposure estimates used to derive them.

RISK*ASSISTANT allows the user to assess the contribution of some aspects of the exposure assessment to uncertainty in the resulting risk estimates. However, there are other sources of uncertainty in these risk estimates that are not addressed by the uncertainty analyses in RISK*ASSISTANT.

- There is uncertainty regarding the accuracy of toxic hazard estimates for humans. IRIS, and the source documents referenced in HEAST, discuss the uncertainty associated with estimates of toxic hazard.

- The specification of contaminant concentrations also entails uncertainty. Actual contaminant concentrations will likely vary across both time and space. The use of models to predict contaminant concentrations may introduce additional uncertainty.

- Pathways of exposure that are not addressed by RISK*ASSISTANT may also contribute to exposure and risk.

7 Uncertainties Regarding Exposure Parameters

One estimate of the uncertainty associated with the risk estimates presented in this report is provided by an examination of the ways in which using alternative values for numerical exposure parameters can change the resulting risk values. The following tables present alternative risk estimates (cancer risks and H.Q.s) for each chemical, when exposure is calculated using 1) average values for all exposure parameters, 2) the values actually used for all parameters, and 3) reasonable maximum exposure (default) values for all parameters. These values indicate the range of risks that might be expected to occur for each exposure scenario, and the position of the risk calculated by the user within (or possibly outside of) this range.

Because inhalation exposures are expressed as concentrations, rather than doses, it is not possible to analyze the influence of alternative exposure parameters on inhalation Hazard Quotients. It is possible, however, to analyze the influence of exposure parameters on carcinogenic risks from inhalation.

INFLUENCE OF ALTERNATIVE PARAMETERS ON RISK ESTIMATES

MEDIA/SCENARIOS	CARCINOGENIC RISK Average	User	R.Max.Exp.	HAZARD QUOTIENT Average	User	R.Max.Exp.
CHEMICAL: 7440-36-0 ANTIMONY						
Soil						
Part. Inside Residence	------	------	------			
Part. Outside Residence	------	------	------			
Ing. of Soil(Child)	------	------	------	8E-001	1E+000	1E+000
Ing. of Soil(Adult)	------	------	------	8E-002	1E-001	1E-001
SUBTOTAL FOR MEDIUM.....	------	------	------	8E-001	1E+000	1E+000
SUBTOTAL FOR CHEMICAL...	------	------	------	8E-001	1E+000	1E+000

7.2 Uncertainties Regarding Scenarios

An alternative approach to estimating the uncertainty associated with the carcinogenic risk estimates and Hazard Quotients presented above is to identify which scenarios, and which contaminated environmental media, make the greatest contribution to the risks for any given contaminant. For example, if a person is exposed to a surface water contaminant both by direct water ingestion and by consuming fish that live in the water, one can ask what portion of the total risk from oral exposure to the contaminant comes from water ingestion, and what proportion from fish consumption. This information can also help to guide the selection of remedial strategies for minimizing risks due to exposure to the contaminants. The following tables present the percentage contribution of each evaluated scenario and medium to the total risks from oral and dermal exposures, respectively, for each contaminant.

These tables do not address the contribution of different inhalation exposure scenarios to the total inhalation Hazard Index for each medium. This reflects the fact that concentration, rather than dose, is used to calculate each inhalation Hazard Quotient. Because of potential disparity in exposure durations and other parameters, Hazard Quotients from different inhalation exposure scenarios may not be commensurate.

RELATIVE CONTRIBUTIONS OF SCENARIOS AND MEDIA TO ROUTE-SPECIFIC RISKS(%)

MEDIA/SCENARIOS	ORAL RISK	H.Q.	INHALATION RISK	DERMAL RISK	H.Q.
CHEMICAL: 7440-36-0 ANTIMONY					
Soil (3.000e+001 mg/kg)					
Part. Inside Residence			---		
Part. Outside Residence			---		
Ing. of Soil(Child)	---	90			
Ing. of Soil(Adult)	---	10			

7.3 Uncertainties Regarding Toxic Hazard Values

For a very limited set of chemicals, toxic hazard values may be estimated from epidemiologic data collected in humans. Most slope factors and RfDs, however, are derived from experimental studies in animals. Such extrapolations are based on the assumptions that:

1) the physiological and biochemical responses of exposed persons will be qualitatively (but not necessarily quantitatively) the same as that seen in the experimental animals,

2) effects seen at high doses in a limited number of animals over a comparatively brief period of observation are predictive of toxicity at lower doses, if a sufficiently large group is exposed for a sufficiently long period.

For some chemicals, hazard values may also have been extrapolated across differing routes of exposure. This introduces additional uncertainty to these estimates. As noted above, this is particularly true for dermal risk estimates that employ hazard estimates based on oral exposures. Because no adjustment is made between the use of administered dose as a basis for hazard estimates and absorbed dose in exposure estimates, these risks may be underestimated.

8.0 References

. IRIS: Integrated Risk Information System.

. HEAST: Health Effects Assessment Summary Tables.

. EPA/600/8-89/043 Exposure Factors Handbook, Final Report. U.S. EPA, Office Office of Health and Environmental Assessment. Washington, D.C. May 1989.

. OSWER Directive 9285.66-03, 3/25/91. Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual. Supplemental Guidance, Standard Exposure Factors: Interim Final.

. EPA/540/1-89/002 Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual.

. Exposure Description: Exposure for Antimony

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